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BOOK REVIEW

What is Nanotechnology and why Does it Matter?: from Science to Ethics

F. Allhoff, P. Lin & D. Moore, 2010 (Oxford, Wiley-Blackwell) ISBN: 978-1-4051-7545-6. 304 pp

Laura Yenisa Cabrera Trujillo

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Nanotechnology has in various ways been regarded as a technology that promises both innovations and risks and that has the potential to profoundly change the world. Yet for many people there are still two questions that remain unanswered: just what is nanotechnology, and why does it matter? *What is nanotechnology and why does it matter?: from science to ethics*, by a nanoscientist and two philosophers, aims to give the reader a balanced and informed understanding of this important technology. The book not only focuses on providing the reader with normative reasons around why nanotechnology matters, such as its social impact and ethics, but also offers an accurate and generally accessible analysis of the science involved, highlighting what nanotechnology actually is and why it matters in terms of the applications and features that make it relevant.

The book serves as a useful introduction to nanotechnology for those who know little about the subject but wish to learn about the impact this technology could have on their lives and about the ethical issues it raises. The book is for the most part easily accessible, with the exception of some of the first chapters in Unit 1 which could come across as overly technical. However, this may be viewed as a positive feature, rather than a negative one, given that few books that discuss the ethical and social issues of nanotechnology offer such a comprehensive review of the science behind nanotechnology. This review of the science behind nanotechnology is indeed a main strength of this book by Allhoff et al., as it is here that a framework is established that permits a better understanding of the societal and ethical issues covered in the subsequent units. In a wider sense, the book can be recommended to both scientists and non-scientists alike, since it deals with a wide range of the questions and problems that are the subject of current debate.

The book is divided into three units. The first focuses on the science behind nanotechnology. In the second the authors provide frameworks that allow an evaluation of the specific ethical and social issues to be discussed in the final unit, including military, medical and enhancement-related applications.

The first unit entitled ‘What is nanotechnology?’ Begins with a chapter that attempts to explain the basic principles of nanotechnology to the reader, addressing definitions and scales, the origins of nanotechnology, the current state and future of nanotechnology, as well as issues relating to nanotechnology in nature and its applications. As the authors state: “Nanotechnology has not only been present in nature, but has also been used unwittingly in human-made technology for centuries” (p.18).

The second chapter focuses on the “tools of the trade” that are used in nanotechnologies and discusses the basic governing theories that have affected them. Reference is made to the development of the electron microscope and to scanning probe microscopy in the context of the former, and to quantum mechanics,

L. Y. Cabrera Trujillo (✉)
Institute of Biomedical Ethics, University of Basel,
Bernoullistrasse,
Basel 284056, Switzerland
e-mail: laura.cabrera@singularityu.org

chemical bonds and crystal structures in the context of the latter. The authors suggest, for example, that "learning about the tools that are used in nanotechnology will allow us to understand how it is being developed and what its limitations are" (p.21).

In Chapter 3, Alhoff et al. turn to the subject of nanomaterials, discussing their formation and looking at carbon-based as well as inorganic nanomaterials.

Chapter 4 focuses on applied nanotechnology, from current applications of nanotechnology (such as stain-resistant clothing and paints to tennis balls that bounce for longer) to the insights into the future of nanotechnology that such applications grant. This chapter also discusses how these current applications work and explains why nanotechnology is vital to their function. It concludes the scientific section of the book and paves the way for Unit 2, which explores risk, regulation and fairness, three concepts that the authors believe to be appropriate in light of the promise and (potential unknown) hazards of nanotechnology.

Chapter 5 is all about risk and precaution. It starts by outlining different interpretations of risk, continues with a discussion of cost-benefit analysis and then introduces the precautionary principles as a means of addressing the main downsides of cost-benefit analysis in terms of uncertainty and the handling of risk. It concludes with a section in which the precautionary principle is evaluated.

Chapter 6 looks at regulation. It opens with a discussion of the stricter-law argument and then presents a number of examples from history. These are followed by a number of objections to the stricter-law argument, including objections relating to ordinary material, the status quo, the precautionary principle and future harms. The next section in this chapter offers a possible interim solution. On the one hand, the authors appear to reject the idea of more regulation (and thus appear to favour an approach based rather on self-regulation). On the other hand, they argue that "to the extent that nanotech is a highly interdisciplinary area, we would expect that collaboration among lawmakers, scientists, economists, and so on would be needed to account for the complicated issues arising from nanotechnology" (p.124). This chapter finishes by asking not whether we need more regulation but why current laws are ill-equipped to deal with nanotechnology.

The final chapter in this unit explores equity and access. At its outset, the authors state that "the issue of distributive justice is hardly privileged in regards to nanotechnology: for any technology or, more generally, any element of some social product, there are questions about fair distribution" (p.126). The chapter offers an overview of the concept of distributive justice, before turning to a discussion of nanotechnology and the developing world. The applications of nanotechnology mentioned in this context include water purification, solar energy and medicine.

The next five chapters discuss the ethical and social implications of a wide range of nanotechnology applications. Chapter 8 describes the environmental risks and potential benefits of nanotechnology. As far as risks are concerned, the toxicity of nanomaterials is emphasized, while potential benefits that are mentioned include the use of nanotechnology for environmental remediation, the fact that it may prevent anthropogenic harm to the environment, and its potential for increasing energy efficiency.

Chapter 9 explores the military applications of nanotechnology, from the way nanotechnology is used to substantially improve the survival chances and performance of soldiers to the development of better defence systems. The last part of this chapter focuses on ethical concerns, discussing several frameworks in which to consider the impact of nanotechnology: for example, to what extent can the technology be transferred to non-military applications, and is its application defensive or offensive in nature.

The next chapter deals with privacy, "one of the central areas in which nanotechnology is expected to have an impact" (p.185). The first two parts of this chapter look at the historical and legal background to privacy and undertake a more topical discussion of its philosophical foundations. The rest of the chapter explores three areas in which privacy may be affected, namely item-level tagging, human implants and radio-frequency identification chips.

Chapter 11 discusses medicine, starting with a general discussion of the rise of nanomedicine and then exploring two areas in which the authors expect the impacts of nanomedicine to be most significant: diagnostics and medical records, as well as treatment, including nanosurgery and drug delivery.

The last chapter in this unit touches on one of the most controversial applications of nanotechnology, namely human enhancement, an area which some see "as a way to fulfil or even transcend our potential", while others see it as a "darker path toward becoming Frankenstein's monster" (p.234). The first section of this chapter deals with the question of what human enhancement is, and then offers a definition according to which the mere use of tools would not count as enhancement,

as the authors believe that this would render the concept invalid. In their view, it is only when such tools become incorporated into our bodies that they constitute instances of human enhancement. The next part of the chapter discusses the therapy-enhancement distinction, suggesting that it can be regarded for the time being as a defensible and illuminative distinction despite its conceptual problems, at least where it aligns with our intuitions. Before proceeding to untangle the issues surrounding enhancement, the authors address a number of scenarios that call into question whether 'enhancement' is the right term to use as opposed, for instance, to 'human engineering'. They mention various issues surrounding human enhancement, such as freedom and autonomy, health and safety, fairness and equity, societal disruption and human dignity.

The closing chapter offers an overall conclusion of the different topics discussed throughout the book, chapter summaries and final thoughts from the authors.

The main criticism that may be levelled against *What is nanotechnology and why does it matter?* concerns in my view the fact that Allhoff et al. attempt to cover so many different topics and issues that they might have neglected a more in depth discussion. Moreover, since the authors wished to remain within the realm of near- and mid-term issues rather than exploring more speculative possibilities, it may be argued that deciding which areas are more speculative than others is no easy task given the interests involved and the rapid advances in certain areas of nanotechnology. In view of the broad range of issues that arise in connection with the ethical and social implications of nanotechnology, however, it is understandable that specific choices needed to be made. There are a number of other points worth considering: first, whilst the overall tone of the book is enthusiastic about the contributions that nanotechnology can make to society, little discussion is devoted to the political, cultural and social frameworks that could perhaps pave the way to achieving this (or that would curtail such promises). Second, the reader is left wondering about other pressing issues such as social responsibility and informed choice with respect to the applications and uses of nanotechnology, and about the growing call for public participation and engagement in decision-making on emerging technologies such as nanotechnology. Finally, the authors claim that nanomedicine has not received as much scholarly attention as other areas of nanotechnology, and suggest that this is mainly because nanomedicine simply "does not raise any social or ethical concern that have not already appeared in other guises" (p.217). However, it can be argued that nanomedicine has in fact attracted greater attention in both academia and industry in recent years, and that although its issues may be similar in nature they may differ in terms of degree, thus meriting further debate.

Despite these criticisms, *What is nanotechnology and why does it matter?* is a very welcome and readable addition to the debates of the social and ethical impact of nanotechnology. It is one the few books that provide a comprehensive explanation of the science and history behind nanotechnology while at the same time presenting an ethical analysis of its impact. As the authors suggest, this approach is necessary in order to achieve a more balanced assessment of the societal impact and ethical issues to which this technology is likely to give rise.

This book deserves to be read by anyone interested in why nanotechnology is important and why it matters, and particularly by anyone new to this field. For those already familiar with some (if not all) of the topics that the book covers, there is still some benefit to be gained from reading about some of the latest applications in areas in which they may not have such detailed knowledge. It also permits the reader to take a critical stance on the topics and arguments raised in the book, especially since the book's objective is to prompt the dialogue that is needed to achieve further progress and to continue to broaden the debates.